DEPARTMENT OF TRANSPORTATION

1INFORMATION COLLECTION
SUPPORTING STATEMENT

Title: Head-Up Displays and Distraction Potential

Part B. Justification

1. Describe potential respondent universe and any sampling selection method to be used.

No statistical methods will be used in selecting test participants.

Eligibility requirements are as follows:

1. Must hold and be able to present a valid U.S. driver's license at time of participation and must be an experienced driver (at least 2 years).
2. Must be in one of the established age groups.
3. Must be a U.S. citizen or permanent resident (green card holder)
4. Must be willing to provide SSN or VT ID number for payment.
5. Must be able to drive an automatic transmission without special equipment.
6. Must currently drive at least 3 times a week.
7. Must not have participated in a similar study (one using a surprise event or deception).
8. Must not have more than two driving violations in the past 3 years.
9. Must not have caused an injurious accident in the past three years.
10. Health Questions:
    a. Cannot have a history of neck or back conditions which still limit their ability to participate in certain activities.
    b. Cannot have a history of brain damage from stroke, tumor, head injury, recent concussion, or disease or infection of the brain
    c. Cannot have a current heart condition which limits their ability to participate in certain activities
    d. Cannot have current uncontrolled respiratory disorders or disorders requiring oxygen
    e. Cannot have had epileptic seizures or lapses of consciousness within the last 12 months
    f. Cannot have chronic migraines or tension headaches (no more than one per month during the past 12 months).
    g. Cannot have current problems with motion sickness, inner ear problems, dizziness, vertigo, or balance problems
    h. Cannot have uncontrolled diabetes (have they been recently diagnosed or have they been hospitalized for this condition, or any changes in their insulin prescription during the past 3 months)
    i. Must not have had any major surgery within the past 6 months (including eye procedures).
    j. Cannot have advanced osteoporosis (softening or weakening of the bones)

k. Cannot currently be taking any substances that may interfere with driving ability (cause drowsiness or impair motor abilities)

11. If pregnant, encourage them to speak with their doctor first.
12. Must have normal (or corrected-to-normal) hearing and vision.
13. Must be able to drive without sunglasses or lenses that darken in the sunlight.
14. Must be able to read, write and speak English well.
15. Must not be involved/employed in the design, engineering, or development of automotive-related technologies.

Test Participant Impartiality. Test participants should be impartial with regard to the testing. To ensure fairness, test participants should not have any direct interest, financial or otherwise, in whether any of the devices being tested meets or does not meet the acceptance criteria.

Mix of Ages in Each 24-Participant Sample.

Participants will be recruited from two different age groups (20–35 years old & 50–65 years old) with an equal gender balance as summarized in Table 1. There are a total of 48 participants.

Table 1. Participant Target Sample.

	Gender	
	Female	Male
Younger Drivers (20 – 35 years old)	n=12	n=12
Older Drivers (50 – 65 years old)	n=12	n=12

The participants will be selected through convenience sampling method. Recruitment advertisements will be posted online (e.g., craigslist) and flyers will be circulated on public sites in Montgomery County, Virginia, such as college campuses, coffee shops, restaurants/fast food establishments, and sports venues.

Information collected pertaining to the above criteria will be solely used to assess individuals' suitability for study participation and will be obtained using a standard set of demographic, driving behavior, and general health questions developed by NHTSA through an ongoing process.

2. Describe procedures for collecting information, including statistical methodology for stratification and sample selection, estimation procedures, degree of accuracy needed, and less than annual periodic data cycles.

No such statistical methods will be employed.

3. **Describe methods to maximize response rate.**

The primary focus of the statistical analysis is to compare participants' driving performance and eye glance behavior with regard to the different display technologies.

Members of the public will be invited to participate in the research study through web-based and print newspaper advertisements. Test participants will be monetarily compensated at an hourly rate corresponding to a civilian, non-professional federal government employee in the locality in which the study is conducted. Monetary compensation is consistent with normal experimental practice and should encourage study participation.The experiment was designed to collect both subjective and objective data on how participants interact with and are affected by Head-Up Display (HUD) technology when driving on public real roads and in a test track scenario. A total of 48 drivers will be recruited for participation in the study.

This sample size exceeds the minimum sample size based on a priori power analyses (alpha = .05, power = .8; estimated reaction time difference 0.5 seconds, SD = 0.3 seconds) using best estimates of response differences.

4. Describe tests of procedures or methods.

Upon arrival, participants will be greeted and taken to a private screening room. The initial informed consent process will then occur. After completion of the informed consent process, participants will be tested for normal vision, as well as for their dominant eye. Recording the dominant eye should assist in the video-based reduction of visual behavior. General demographic information will be collected via questionnaire.

Participants will then be led to the experiment vehicle, the 2010 Buick LaCrosse, and oriented to the vehicle controls. The HUD displays will then be positioned for each participant.

The initial setup of the OEM HUD will be adopted from Kiefer (1998a). The owner's manual for the research vehicle advises drivers to adjust the HUD as low as possible in their field of view while the entire HUD image remains fully visible (i.e., so the HUD appears just above the driver's front hood). At the start of testing, the top of the HUD will be set for each driver at approximately 8 degrees below the driver's visual horizon. This initial setting may occlude part of the HUD for some drivers, and will be adjusted as needed (i.e., adjusted upward until the entire HUD is visible). This adjustment may cause the HUD to project onto the roadway. The average look-down angle across all drivers will be measured and recorded.

In the aftermarket HUD condition, the aftermarked HUD will be positioned in front of the driver, at the same height, but offset slightly to the right of the OEM HUD position. The aftermarket HUD projects directly onto a reflector that sticks to the windshield. This positioning allows for the reflector to remain on the windshield even if the aftermarket HUD is not in use in a way that

does not interfere with the OEM HUD projection. When reflected onto the windshield, the aftermarket HUD will also have a look-down angle of approximately 8 degrees.

The Head Down Display (instrument cluster) is located at approximately 20 degrees below the driver's visual horizon.

In practice, the HUD and HDD look-down angles will vary somewhat between drivers, depending the height, eye position, seat position, and preference.

Each driver's test session will take place on public roads and the Virginia Smart Road, a 2.2-mile controlled test track. Testing on public roads will allow the investigation of drivers' visual behavior, vehicle control, and task completion time under normal traffic demands. Testing on the Virginia Smart Road will allow the controlled investigation of drivers' emergency response to surprise events when looking at a display.

The public road component will consist of drivers following an orange VDOT pickup truck at 60 mph. Drivers will experience three conditions that involve reading information displayed on an OEM HUD, aftermarket HUD, and OEM HDD. The public road course consists of a 14-mile stretch of road on a two-lane divided highway in Christiansburg, Virginia.

Each driver will experience the OEM HUD, the aftermarket HUD, and the OEM HDD on a separate lap in a counter-balanced order. Their task completion time, eyes-off-road time, eyes-on-display time, mean speed, standard deviation of speed, mean headway, standard deviation of headway, standard deviation of lane position, and subjective opinions of interacting with the display will be measured. Drivers will also wear a lightweight, head-mounted camera that will capture what aspects of the roadway are obstructed by the HUD images.

Drivers will then be asked to follow the lead pickup truck onto the Virginia Smart Road. The purpose of this component is to investigate drivers' emergency response performance to a surprise event in a controlled and safe manner. Drivers will be asked to perform a task "that is too hard to be performed on public roads" with the display. Unknown to the driver, the lead pickup truck will drop a cardboard box at the command of the in-vehicle experimenter. The box-drop event will be executed as the driver engages in a task with a display. The display the driver is asked to use will either be the OEM HUD, the aftermarket HUD, the OEM HDD, or no display at all (i.e., drivers will not be asked to look at a display during the surprise event).

This task is expected to mimic cognitive capture of the display as it will require counting through the characters on the display. Drivers' response performance to the surprise event will be measured in terms of gaze response time, throttle response time, brake response time, and swerve response time. Furthermore, the head-mounted camera will capture whether the HUD image obstructed the drivers' view of the cardboard box. Afterwards, drivers will be debriefed. Those that elect to continue the study will have their data included in the final analysis. Their response performance across the four display conditions will be investigated using between-subjects statistical analyses.

Questionnaire responses will be initially collected on paper. Data processing will consist of tabulation of quantitative and coded open-ended responses. Data analysis will be conducted by NHTSA's contractors, VTTI. Since individual differences may not be randomly distributed across conditions, VTTI plans to use non-parametric statistics and descriptive statistics to test observed effects between different display technologies. Summary statistics will be analyzed to determine whether or not significant differences exist between the rating evaluations of different display technologies based on reported acceptance, satisfaction, and self-reported distraction. Open-ended responses will also be analyzed to add context to the evaluations participants have provided and can help in assessing the display features.

All the questionnaires have not been distributed to anyone who is outside of this research team. The designed questionnaires have been distributed to the research team members (less than ten individuals) for validation.

Data tables, including important cross-tabulations, will be prepared along with a final report of the key findings.

5. Provide name and telephone number of individuals who were consulted on statistical aspects of the IC and who will actually collect and/or analyze the information.

In preparation of sending this package to OMB for approval, NHTSA provided contacts at various agencies the opportunity to comment on the approach for this plan. The following individuals are primarily responsible for data collection and analysis:

Myra Blanco, Ph.D (PI) Research Scientist 240-231-1551	**Virginia Tech Transportation Institute** 3500 Transportation Research Plaza, Blacksburg, VA 24060
Sheldon Russell, Ph.D (Project Manager) Research Associate 240-231-3302	**Virginia Tech Transportation Institute** 3500 Transportation Research Plaza, Blacksburg, VA 24060